THE ECOLOGICAL MIGRATION PROJECT: THE CASE OF RTSWA CHOG QINGHAI PROVINCE, CHINA

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ABSTRACT
Continuing grassland degradation in China stresses the importance of effective management strategies. This study focuses on the impact of the Ecological Migration Project (EMP), a large-scale grassland recovery strategy, on the Tibetan herding community of Rtswa chog in Upper Ra shul Township, Yushu County, Yushu Tibetan Autonomous Prefecture, Qinghai Province, China. The impact of EMP on the local grassland ecosystem was studied from September to October 2007 by comparing grassland conditions of Rtswa chog to grassland conditions of Yul gyi nyi ma, a nearby, similar herding community where EMP had not been implemented. Species richness and species composition diversity indices, as well as socio-economic indicators of the resettled herding community were investigated, revealing that EMP implementation reduced livestock numbers. However, grassland condition was not improved, nor was biodiversity of the area enriched. Moreover, resettled herders felt disenfranchised and were deprived of a sustainable livelihood under EMP.

KEY WORDS
Ecological Migration Project (EMP), nomads, Qinghai, pastoralists, Tibetan herders, Yushu

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INTRODUCTION

The Tibetan Plateau is an important but ecologically fragile region encompassing approximately 87% of Qinghai Province's land area (Miller 2006). Addressing rapid grassland degradation requires a management policy that alleviates poverty while restoring the ecosystem. In the past two decades, several grassland management strategies have been implemented, including the Ecological Migration Project (EMP), which began in Qinghai Province in 2003.

There are few reviews of the success of EMP in terms of grassland restoration, such as that by Foggin (2008). Furthermore, EMP's socio-economic impact is poorly understood, as there is a dearth of empirical research measuring the project's ecological impacts on grassland ecosystems. Meanwhile, more EMP implementations are anticipated, thus an early assessment of this on-going project is crucial to better understand its impact. EMP is controversial as evidenced in debates on violations against human rights (Enghebatu 2006) and property rights, degrading living conditions of herders (Meyer 2006), and loss of cultural identity (Miller 2006). Little research has been done on ecological aspects.

This study focused on one EMP site, Rtswa chog, a herding community in Upper Ra shul Township, Yushu County, Yushu Tibetan Autonomous Prefecture, Qinghai Province. The impact of EMP on the grassland ecosystem was assessed by comparing grassland conditions in terms of species richness and species composition diversity indices of Rtswa chog to the nearby, similar community of Yul gyi nyi ma, where EMP had not been implemented.

Ten percent of the population from each study site was randomly selected and interviewed. These interviews provided data on commonly observed birds, mammals, livestock density, and socio-economic aspects of life in the two communities. A quadrat biological sampling method was employed to assess the characteristics of meadow vegetation.

GRASSLAND AND EMP

Over 40% of China's total land area is grassland that supports a rich diversity of plant and animal life. Pastoralists on the Tibetan Plateau have raised livestock for at least 4,000 years (Barfield 1993, Lattimore 1940). According to Miller (2006), over 260 million hectares of grassland in China are being degraded at the alarming rate of 6,700 square kilometers per year. Wang et al. (2005) reported that grasslands in Dar lag and Rma stod counties in Mgo log Tibetan Autonomous Prefecture are severely degraded. Grassland degradation in Dar lag increased from 8.07×10^4 in 1989 to 20.62×10^4 hm^2 in 1997. According to Meyer (2006) degradation is due to the advocacy of self-sufficiency in 1949, the Great Leap Forward in 1958, and conversion of grassland to cropland during the Cultural Revolution. Miehe (1988) argues that degradation was due to climate change while the Chinese state claims grassland degradation is due to herd mismanagement by pastoralists (Ellis and Swift 1988).

Grassland degradation has had a direct and negative impact on herding communities across the plateau. Herding communities are furthermore directly affected by state-sponsored efforts to alleviate grassland deterioration through resettlement, essentially making herders environmental refugees.

Several solutions have been offered to address grassland degradation and desertification in China. The state's enforcement of the Grassland Household Responsibility System and EMP have been major strategies. Theoretically, such strategies simultaneously allow grassland restoration and improve herders' living conditions. This project has been implemented on a large scale in Qinghai, and has also been conducted in such other herding areas as the Inner Mongolia Autonomous Region.

EMP was first implemented in Qinghai Province in 2003 under the Qinghai Province Three Rivers' Source Natural Reserve Ecological Protection and Construction Blueprint, with the goal of restoring the grassland and improving the living conditions of relocated herders. This direct field experiment on the Tibetan Plateau still lacks empirical pre-project assessment and post

project evaluation. The outcomes of EMP must be considered as crucial for further implementation of EMP on Tibetan Plateau.

In this context, this study aimed to document EMP in terms of its first major objective: grassland restoration. Specifically, this study attempted to determine the impact of EMP on the grassland ecosystem of the herding community of Rtswa chog by answering the following questions:

- Did implementation of EMP reduce the number of livestock in Rtswa chog?
- What are the effects of EMP on the grassland ecosystem in terms of grassland species richness and grassland species composition diversity indices?
- What are the socio-economic impacts of EMP on relocated Rtswa chog natives?

CONCEPTUAL FRAMEWORK

Livestock are part of the grassland ecosystem, and depend on and nourish the grassland through a symbiotic relationship. For centuries, Tibetans have herded with little damage to the grassland, further suggestive of a mutual, beneficial relationship between livestock and grassland.

The current environmental crisis on the Tibetan Plateau affects herders, whose livelihood depends on grasslands, and also millions of residents at lower elevations in China, Bangladesh, Cambodia, and Thailand, as these populations depend on rivers that originate on the Tibetan Plateau. The current situation of grassland degradation in northern China has strongly influenced the state's perception of grassland conditions and pastoral practices (Goldstein et al. 1990, Miller 2006). Research in certain severely degraded grassland areas became the core of policy-making. Drawing evidence from such research, it was assumed that the culprits were increased livestock numbers in pastoral areas and inadequate management by pastoralists. The state thus implemented EMP to sustain the grassland ecosystem and restore

the grassland. From the state's perspective, the relationship between livestock and the grassland ecosystem is parasitic, with livestock damaging the grassland.

Livestock represents the herders' only real economic enterprise on the grassland; it is the pillar of their sustenance. Reforms targeting livestock therefore directly affect pastoralists' survival.

EMP was implemented in western China, where 95% of the land is dominated by grass (Yeung and Shen 2004). Moving herders from pastoralist areas and prohibiting herding has been called 'Ecological Migration' by state authorities and aims "to restore ecological balance" as it "shakes-off poverty".[2] EMP is expected to restore degraded grasslands by removing herders from the grassland and in so doing, eliminate their livestock.

In assessing the ecological impacts of EMP on grassland conditions, indicators include biodiversity richness and grassland composition diversity indices. Biodiversity richness was determined by the presence of different grass and animal species. The grassland composition diversity indices were measured by dominant grassland species coverage, density, and frequency. The extent to which EMP restores grassland conditions reflects its effectiveness.

RESEARCH SETTING AND TIME

Research was conducted in three sites in Yushu County: Rtswa chog Herding Community where EMP was implemented in 2004, Yul gyi nyi ma Herding Community of Lower Ra shul Township where EMP had not been implemented, and Skye dgu Town, where the herders of Rtswa chog were resettled. The main focus of the study was Rtswa chog where thirty households were resettled in Skye dgu Town in 2004.

[2] http://www.cafte.gov.cn/english/NEWSROOM/20041110/1256.asp, accessed 21 August 2010.

Rtswa chog is a herding community located in Yushu County. Yushu Prefecture is one of Qinghai's six ethnic autonomous prefectures and is located in the south of the province.[3] The prefecture has six counties, forty-five townships, and 331,733 people, 96% of whom are Tibetan. Han, Hui, Salar, and Mongols make up the remainder.[4] The average elevation is 4,500 meters above sea level.

There are three towns and five townships in Yushu County. There were approximately 90,000 people of whom 93% were Tibetan in 2006.[5] The area is in the high altitude frigid zone, with significant temperature variation between day and night and relatively little temperature variation in a year. The average annual temperature is around 2.9°C.

Rtswa chog is located at 32°54′ N, 96°29′ E, at 4,221 meters above sea level, in the southwest of Yushu County, seventy-five kilometers from Skye dgu Town, the economic and political center of the prefecture. There are approximately 6,000 people in Upper Ra shul Township of whom the vast majority are Tibetan. Rtswa chog is one of seven administrative herding communities in Upper Ra shul Township.[6]

Rtswa chog is a herding community of 140 households (800 people). From May to August, herders lived in widely separated tents in their summer camp at high altitudes. From September to April, they lived in their winter camp in adobe houses near one another, creating a sense of community.

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[3] Yushu, Mgo log, Rma lho, Mtsho byang, and Mtsho lho are all autonomous Tibetan prefectures. Mtsho nub is a Mongolian and Tibetan Autonomous Prefecture.

[4] http://www.qh.xinhuanet.com/misc/2008-05/20/content_13313375. htm, accessed 2 February 2009.

[5] http://www.qh.xinhuanet.com/misc/2008-05/20/content_13313375. htm, accessed 2 February 2009.

[6] The other six herding communities are Chu shar, Ri ma, Ma rang, Bsam rnying, Bor rog, and Rdo ra.

Dairy products (butter, milk, yogurt, dried cheese), meat (beef and mutton), and *rtsam pa*[7] are important foods. The raw material for *rtsam pa* – barley – is bought from Rdo la, the political and economic center of Upper Ra shul Township, about three hours by motorcycle from Rtswa chog. Barley is roasted and then ground using a water-powered mill. Livestock are butchered every November.

In both Rtswa chog and Yul gyi nyi ma, yaks were the main livestock, providing herders with nearly all basic livelihood needs: milk, butter, cheese, yogurt, and meat for food; and yak hair and skins for clothes and tents. Sheep and goats were less valued because wolves more easily attacked them. Moreover, goats and sheep cannot be herded together with yaks, and thus an additional person was required to herd them. Goats were kept for cashmere, which was collected annually, and provided what was considered a small portion of household income. Horses were a major means of transportation in the past, however, they were expensive and few in number. An increase in the number of motor vehicles in herding areas, particularly motorcycles, further reduced the horse population.

A main source of cash income for local herders is the collection and sale of caterpillar fungus (*Ophiocordyceps sinensis*), which has a two-month harvest season (May to June). Caterpillar fungus in the area is of poor quality and sparsely distributed. Each local adult caterpillar fungus collector earned an average of 2,000 RMB from this source in 2008. Due to the remoteness of the location, residents have limited trade opportunities.

The local environment is such that agriculture has never been practiced.

No baseline information on grassland conditions prior to implementation of EMP in Rtswa chog exists. Thus, Yul gyi nyi ma was chosen as a study site for comparative purposes. Yul gyi nyi ma is located at 32°46′N, 96°38′E. Rtswa chog and Yul gyi nyi ma have similar physical conditions, though Yul gyi nyi ma is

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[7] Ground, roasted barley.

approximately 100 meters lower than Rtswa chog. Both sites have a short growing season and a long winter.

A few leaders of Upper Ra shul Township were taken to sites in Mgo log where EMP had been implemented to visit families in the resettled areas in 2004. According to one leader interviewed in September 2007, living conditions were excellent and the government regularly compensated the resettled herders. In addition, several skills-training projects were conducted for resettled herders. Based on these observations, community leaders agreed to implement EMP in Upper Ra shul Township.

A relocation quota of 200 households was assigned to Upper Ra shul Township. Relocation was voluntary. In early 2004, more than thirty households from Rtswa chog volunteered to be relocated to the southwest part of Skye dgu Town in a valley located at 32 59.6' 96 59.0'E, and at an elevation of 3,990 meters above sea level. The government promised each family a house worth 40,000RMB (5,000USD) and annual compensation of 6,000RMB (750USD). Training programs, subsidies for impoverished families, and the chance to return to the grassland after ten years were also promised.

The resettlement area is in a valley south of Skye dgu. Each household was assigned three rooms within a courtyard. The gray houses in the valley are the resettlement area (Figure 1). There were a few small private stores in the resettlement area selling snacks, student supplies, and so on, but no nearby markets, hospitals, or other social amenities. To access such services, the resettled herders needed to go to the other side of the valley, taking about an hour on foot.

Figure 1. The Skye dgu resettlement site, Upper Ra shul Township.

In assessing EMP's effect on herders' living conditions, it is important to understand general living conditions in the pastoral areas. When herders have a surplus of products, they barter with other communities to obtain clothes, fuel, and other necessities. Herders' livelihood is usually stable in the absence of major natural calamities.

Aside from livestock, a major source of income is caterpillar fungus. Herders also collect such other medicinal herbs as *Gentiana macrophylla* for income and gather wild yams and mushrooms for household consumption. Herders' cash expenses are very low and mostly related to illness. No money was spent on water (which was drawn locally) or electricity (which was not available) and very little was spent on clothing before resettlement. Even though the herding households were widely separated, there was a strong sense of community. All locals participated in annual activities and rituals. For instance, all households gathered for an annual summer festival. In winter,

the community celebrates Lo gsar (Tibetan New Year) together, and families invited each other to their homes.

METHODS

Research Instruments

Three research instruments were employed:

- Gathering relevant secondary data for physical attributes from the internet and such institutions that regularly monitor the area as the Upper Ra shul government.
- Quadrat biological sampling to determine species richness and composition diversity by systematically sampling and listing species and the number of individuals per selected plot. Sampling was conducted in both Rtswa chog and Yul gyi nyi ma.
- Interviews and field observations to estimate faunal diversity. A checklist of birds and mammals was prepared and the respondents were interviewed about species they often observed and the frequency of their observation. There were 140 households in Rtswa chog, 185 in Yul gyi nyi ma, and 200 households in the resettlement area in 2007. A randomly selected 10% sample from the three sites served as respondents.

Data Collection

Biological sampling was implemented by randomly designating a 32 × 32 meter grassland plot at each study site. These plots were further divided into sixty-four subplots of 4 × 4 meters. Plots were then numbered and fifteen plots selected at each site using a random sampling method, giving a total of thirty sample plots. Next, fifteen mini-plots of 1 × 1 meter were laid out within each

subplot. All grass species and the number of individuals per mini-plot were counted and recorded.

This study was conducted from September to October 2007. Snow covered the mountain peaks during the research, and only a few plants were in flower in early September. Most vegetation was dry in late October and most perennial plant species had withered. Some birds were inactive or absent during winter and mammals were hibernating, therefore, lower species diversity was observed.

Indicators and Formulas

Species composition diversity was measured according to three parameters: density, frequency, and dominance. The density and frequency formulas used were as follows (Arances et al. 2004):

$$\text{Density} = \frac{\text{number of individuals}}{\text{area sampled}}$$

$$\text{Frequency} = \frac{\text{quadrat number where species A occurred}}{\text{total number of quadrats examined}} \times 100\%$$

Dominance = the area covered by the species divided by the total area sampled

A t-test was applied to compare biodiversity richness and grassland conditions of Rtswa chog and Yul gyi nyi ma. The mean, median, and standard deviation were applied as livestock density indicators.

RESULTS AND DISCUSSION

The Ecological Impacts of EMS

Livestock Reduction. The rationale of EMP intervention assumed that the number of livestock would decline (Figure 2) after implementing EMP because thirty Rtswa chog households had been resettled in Skye dgu. Figure 2 below provides a comparison of livestock numbers before and after the implementation of EMP.

Figure 2. Livestock reduction in Rtswa chog.

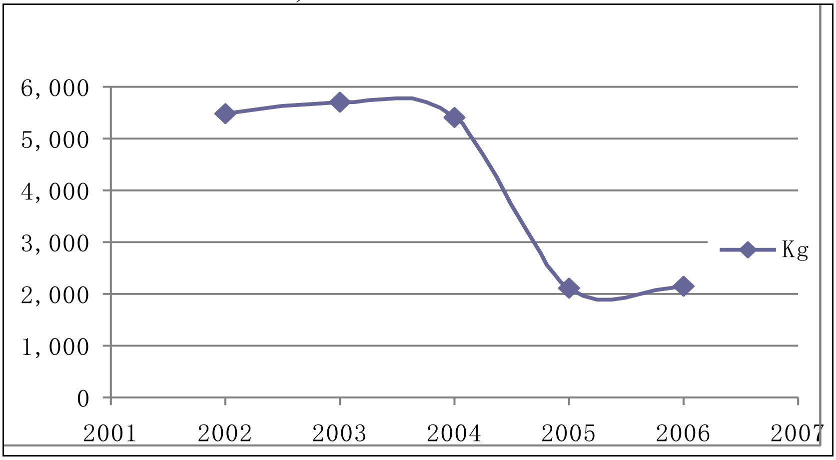
Livestock	Before EMP (2004)	After EMP (2006)	+/-
Yaks	8,735	7,535	-1,200
Horses	289	259	-30
Sheep and goats	2,810	2,420	-390
Total	11,834	10,214	-1,620

The government offered free housing and compensation to the thirty poor herding households that were resettled. On average, herders who were resettled had fewer livestock before resettlement than those who remained in Rtswa chog. Prior to the implementation of EMP, each Rtswa chog household had an average of sixty-eight yaks, twenty-two sheep and goats, and two horses, whereas the families that were resettled had an average of forty yaks, thirteen sheep and goats, and one horse. For the thirty resettled households, this represents a reduction of 1,200 yaks, 390 sheep and goats, and 30 horses.

According to certain Skye dgu residents, the resettled herders kept some livestock in the pastures, though Rtswa chog residents contested this. Furthermore, the resettled pastoralists insisted that they sold all their livestock before resettlement as they were told that failure to do so would result in being denied their government subsidy. Furthermore, herders lacked furniture appropriate for a sedentary life and thus needed cash to furnish and decorate the houses provided by the government.

Rtswa chog butter production validates the reduction of livestock (Figure 3). According to the Upper Ra shul Township Government, butter production declined after EMP implementation. It remained constant from 2002 to 2004 but from 2004 to 2005, the first year of EMP implementation, there was a sharp decrease, mirroring a corresponding reduction in livestock number.[8] Moreover, the constant level of butter production beginning in 2005 indicates that no dramatic increase in livestock occurred thereafter.

Figure 3. Rtswa chog butter production, 2002-2006 (Upper Ra shul Government 2007).



Although a clear trend in reduced livestock numbers is visible, the impact of reduced livestock numbers is unclear. While the government assumes that reduced livestock numbers leads to grassland restoration, herders argued that livestock eat grass and nourish soil with their waste, thus improving pasture growth and preventing invasion of aggressive species that may dominate the grassland. One respondent said that although a non-grazed area may have tall, dense grass, pasture growth the following year would be very poor. In contrast, even though grass

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[8] The number of yaks only fell by 14%, while the butter production fell by more than 60%, emphasizing the challenges of using, at least in this case, government data.

may seem short and sparse in grazed areas, grass growth the following year is very good and various plant species grow evenly. This is evident in fenced areas, where herders are prohibited from herding the entire summer season, and where *Kobresia spp*. and *Polygonum viviparum* are the dominant species.

In the case of Yul gyi nyi ma (Figure 4), each household had an average of seventy-five yaks, two horses, and seventeen sheep and goats. Yul gyi nyi ma had a total land area of 341.2 square kilometers with 185 households and 17,390 head of livestock.

Figure 4. Livestock per household in Yul gyi nyi ma.

Livestock	Number	Density (head of livestock/ km^2)
Yaks	75	
Horses	2	
sheep and goats	17	
Total	94	0.02

The number of livestock per household in Yul gyi nyi ma was assessed and compared with that of Rtswa chog (Figure 5) to determine if the current grassland condition of Yul gyi nyi ma was attributable to its relatively higher stocking rates.

Figure 5. Comparison of Rtswa chog (R) and Yul gyi nyi ma (Y) livestock populations, 1 = Yaks. 2 = Sheep and goats. 3 = Horses. October 2007.

Detail	1		2		3
	R	Y	R	Y	R
mean	68.50	74.80	22.00	16.70	2.60
SD	25.00	34.50	27.40	18.30	2.10
total	753.00	1,422.00	244.00	317.00	29.00
N	11.00	19.00	11.00	19.00	11.00
t-test		0.53		0.65	0.08

N: Sample Population R: Rtswa chog Y: Yul gyi nyi ma *df=28 a=0.01 t(a)=2.763; t<t(a)*

Figure 5 shows differences in the number of livestock between the two sites. The critical value of t*(a)* is 2.763, which is higher than the computed values, suggesting there was no significant difference in individual household livestock number between Rtswa chog and Yul gyi nyi ma.

EMP had not been implemented in Yul gyi nyi ma in 2007. Although there was no significant difference in the number of livestock per household between the two sites, there were 110 households in Rtswa chog after EMP, and 185 households in Yul gyi nyi ma. Therefore, the total number of livestock in Yul gyi nyi ma was higher than in Rtswa chog. The findings on species richness and species composition diversity at the two sites therefore reflects the impact of livestock numbers, and thus the implementation of EMP.

Species Richness. There was no significant difference between the two sites in terms of species richness (Figure 6), as indicated in Figure 6.

Figure 6. Mammal species richness in Rtswa chog and Yul gyi nyi ma.

Detail	Site	
	Rtswa chog	Yul gyi nyi ma
number of grass species	10	11
number of bird species	3	3
number of mammal species	10	8

The raw data revealed that Rtswa chog had more mammal species and Yul gyi nyi ma more grass species. Herders reported observing a brown bear and a wild ass in Rtswa chog in 2007. Rtswa chog elders said such wildlife was commonly observed before the 1960s and that poaching accounted for the current absence of wildlife.

The three most commonly observed bird species were *Gyps himalayensis* (Himalayan Griffon Vulture), *Falco cherrug* (Saker Falcon), and *Gypaetus barbatus* (Bearded Vulture),

indicating an abundance of small mammals in the area, which are also summer food for foxes, wolves, bears, snow leopards, and eagles. Small mammals are generally herbivores that occasionally eat insects.

The two most commonly observed small mammals in both sites were the Plateau Pika (*Ochotona curzoniae*) and the Himalayan Marmot (*Marmota himalayana*). The pika's digging of interconnecting burrows is considered a major cause of grassland degradation. Herders explained that pikas do not initiate grassland degradation but do accelerate the process. According to the Yushu Grassland Station, pikas occupy grasslands already in the process of degradation.[9]

An effort to eliminate pikas was initiated in 2001 in Rtswa chog by spraying a chemical pesticide on the pasture. This aggrevated rather than stopped the infestation. Following the poisoning the population inititally declined over a period of two years, but then recovered and appeared to have become resistant to the pesticide by 2004.

Pikas, marmots, and Woolly Hares (*Lepus oiostolus*) were observed at greater frequency in Rtswa chog than in Yul gyi nyi ma, indicating that the grassland condition of Rtswa chog was more degraded than in Yul gyi nyi ma. An average of six hares, eighteen pikas, and eleven marmots were observed by the Rtswa chog respondents per day, while an average of four hares, twelve pikas, and eight marmots were observed per day in Yul gyi nyi ma by local residents. According to Breivik (2007), some nomads in Yushu believe religious rituals can control pikas. Certain Rtswa chog nomads considered poisoning pikas to be immoral and a violation of their religious beliefs. Local Rtswa chog residents also viewed it as a risk to humans. Several Rtswa chog residents became sick from eating mushrooms that had been exposed to these poisons. In addition, Smith and Foggin (1999) argued that large-scale killing of pikas may harm the grassland, is a great disturbance to the food chain, and on a larger scale, is an unwanted interruption to the entire grassland ecosystem.

[9] Interview with Yushu Grassland Station officers.

Marmots were commonly observed during the study. Marmots are herbivores that dig burrows for shelter and hibernation, requiring much energy and time. Burrows are used repeatedly by successive generations for decades. Marmots collect and transport dried vegetation to their burrows for bedding twice yearly.

The outbreak of pikas and marmots at Rtswa chog was due to the expansion of their ecological niche via pasture degradation, which provided them with preferred habitat. In addition, reduction of natural predators such as foxes, snow leopards, eagles, and wolves through poaching encouraged population growth of small, burrowing mammals, further aggravating grassland degradation.

Local herders rarely observed snow leopards and eagles. The number of foxes was also greatly reduced due to the high economic value of fox fur. According to local residents, one or two foxes were observed yearly in remote pastures and less degraded areas.

Grass Species Dominance. Ten different plants were observed (Figure 7) in the fifteen mini-plots at Rtswa chog. Low-growing sedges of *Kobresia spp*. were the dominant species in Rtswa chog, covering 72% of the sample area, with 31,607 individuals in the fifteen mini-sample plots. *Anaphalis spp.* was the second-most dominant species, occupying 10% of the sample area, with 4,487 individuals, followed by *Potentilla anserina* with 2,965 individuals. Respondents stated that *Kobresia spp.* is the main fodder consumed by livestock during autumn and winter. Other plant species dried in autumn and were easily blown away.

Figure 7. Number of individual plant species at Rtswa chog and Yul gyi nyi ma.

Species	Rtswa chog	Yul gyi nyi ma
Kobresia spp.	31,607	17,557
Anaphalis spp.	4,487	5,153
Potentilla anserina	2,965	2,439
Polygonum viviparum	1,216	1,620
Gentiana autumnalis	983	1,000
Gentiana macrophylla	755	298
Astragalus mollissimus	704	848
Rheum spp.	553	89
skyur ru[10]	433	563
Sedum rosea	73	0
Geum rossii	0	121
Lamiophlomis rotata	0	5

Eleven grass species were recorded within the fifteen mini-plots of Yul gyi nyi ma. Like Rtswa chog, *Kobresia spp.* was the dominant species, occupying 59% of the sample area with 17,557 individuals. *Anaphalis spp.* was the second dominant species, occupying 17% of the area with 5,153 individuals. *Potentilla anserina* was the third dominant species in the area with 2,439 individuals.

Vegetation on the two sites was compared. Results indicated that the dominant species in both sites were *Kobresia spp*. and *Anaphalis spp.* These findings suggest that the dominant species coverage in Rtswa chog and Yul gyi nyi ma was similar.

Vegetation Density. The general composition of grass species on the two sites was very similar (Figure 8). *Kobresia spp.* had the highest density in both Rtswa chog and Yul gyi nyi ma and was the main pasture species. Its short-stemmed form explains why it is not blown away by winter winds. Livestock mainly ate *Kobresia spp.* in winter when other vegetation was unavailable. *Anaphalis spp.* also had very high density in both areas, and also

[10] *Skyur ru* is a local Tibetan plant name, Latin name unknown.

served as livestock fodder. *Polygonum viviparum* has high density but soon dries and blows away after autumn.

Figure 8. Density of vegetation on the two sites (spp./ m^2).

Names		Site	
Local Name	Scientific Name	Rtswa chog	Yul gyi nyi ma
rtswa mdong mgo	*Kobresia* spp.	2,107.0	1,170.0
spar	*Anaphalis* spp.	299.0	343.5
gro ma	*Potentilla anserina*	197.7	162.6
me lo	*Polygonum viviparum*	81.0	108.0
a lpags khra lpags	*Gentiana autumnalis*	65.5	66.7
sdong bu shu res	*Gentiana macrophylla*	50.3	19.9
khyu lde me tog	*Astragalus mollissimus*	46.9	56.5
yis mo rna ldeb	*Rheum* spp.	36.9	5.9
skyur ru		28.9	37.5
mgo gzer me tog	*Sedum rosea*	4.8	0.0
ser chen me tog	*Geum rossii*	0.0	8.0
ru rta	*Lamiophlomis rotata*	0.0	0.3

Kobresia spp. had the highest density among vegetative species in Rtswa chog and *Anaphalis spp.* had the next highest density at 299 individuals per square meter. *Anaphalis spp.* is a medicinal herb used in moxibustion. *Sedum rosea,* which is rarely observed in the area, had the lowest density at approximately five individuals per square meter. *Rheum* spp. and *skyur ru* also had low densities of 36.9 and 28.9 individuals per square meter, respectively.

According to the Rtswa chog community leader, *Gentiana macrophylla* was frequently harvested by locals and outsiders a few years ago because of its medicinal and economic value, but this left exposed black sand, which led locals to ban its digging.

In the case of Yul gyi nyi ma, *Kobresia spp.* also had the highest density with 1,170 individuals per square meter. Similar

to Rtswa chog, *Anaphalis spp.* had the second highest density at 343.5 individuals per square meter. Although *Lamiophlomis rotata* and *Geum rossii* were observed in Yul gyi nyi ma, they were not widely distributed and had the lowest density in the area. *Rheum* spp. had a low density of 5.9 individuals per square meter, similar to *Gentiana macrophylla*. *Sedum rosea* was not observed in Yul gyi nyi ma.

Locals consider *Rheum* spp. and *Lamiophlomis rotata* to be poisonous. *Rheum* spp. was observed in both Rtswa chog and Yul gyi nyi ma. It has a restricted and clumped distribution pattern; it had a very low density in both areas, particularly in Yul gyi nyi ma. *Rheum* spp. had a density of thirty-seven individuals per square meter in Rtswa chog compared to six individuals per square meter in Yul gyi nyi ma. This indicated a high degree of grassland degradation in Rtswa chog, as poisonous species are indicators of grassland degradation. In the case of Rtswa chog, clumped *Rheum* spp. was mainly observed near pika burrows. *Lamiophlomis rotata* was only observed in Yul gyi nyi ma at the very low density of 0.2 individuals per square meter.

Species Frequency. Kobresia spp. had the highest frequency in both Rtswa chog and Yul gyi nyi ma, occurring in all fifteen mini-sample plots of both Rtswa chog and Yul gyi nyi ma (Figure 8). *Potentilla anserina* was similar in occurrence to *Kobresia spp.* in Rtswa chog. *Kobresia spp.* was the main fodder for livestock, and due to the similar physical attributes of the two sites, the dominant species of the two areas were the same. However, in Yul gyi nyi ma, *Potentilla anserina* had the second highest frequency. *Anaphalis spp.* had the second highest frequency of occurrence in Rtswa chog. According to Rtswa chog residents this distribution pattern was due to the low level of the water table, especially at the feet of mountains. *Polygonum viviparum* and *Astragalus mollissimus* had the same frequency in both locations.

Polygonum vivipara belongs to the Polygonaceae family and prefers depressed habitats in both sub-alpine and alpine

zones. *Polygonum vivipara* is adapted to the short growing seasons, cold temperatures, and strong dry winds that typify alpine environments. It reproduces asexually. *Astragalus mollissimus* belongs to the legume family and was not abundant at either site.

Skyur ru had the lowest frequency among all species in Rtswa chog and was not commonly observed at either plot. In the case of Yul gyi nyi ma, *Lamiophlomis rotata* was the least frequently observed plant.

Geum rossii and *Lamiophlomis rotata* were not observed in the sampled area in Rtswa chog. This, however, does not indicate absence of the two species in the area. *Geum rossii* is a common meadow species that prefers moist soil. The research time may explain the absence of *Geum rossii* in sampled plots. *Lamiophlomis rotata* was likewise not observed in the sampled plots of Rtswa chog and it was not abundant in Yul gyi nyi ma, indicating its sparse distribution. *Sedum rosea* was not observed in Yul gyi nyi ma, but occurred in small numbers in Rtswa chog. *Rheum* spp. also had a low frequency of 27% on both sites, mainly due to its clumped distribution.

Figure 9. Frequency of grassland site plant species (%).

Species	Site	
	Rtswa chog	Yul gyi nyi ma
Kobresia spp.	100	100
Potentilla anserina	80	100
Anaphalis spp.	67	47
Gentiana autumnalis	50	40
Polygonum vivparum	40	40
Astragalus mollissimus	40	60
Rheum spp.	27	60
skyur ru	20	27
Sedum rosea	30	27
Geum rossii	None	none
Lamiophlomis rotata	None	53

There were no significant differences in dominant plant species coverage, density, and frequency between Rtswa chog and Yul gyi nyi ma. The difference in species occurrence and frequency was primarily due to variance in soil type and water availability at the two sites. It was further observed that species such as *Geum rossii* and *Lamiophlomis rotata* were not abundant. Poisonous grasses were clumped and infrequent at both sites.

EMP'S SOCIO-ECONOMIC IMPACT

The resettled herders claimed that living conditions were good during the first year after relocation because they had cash from selling livestock. After spending this money, basic subsistence became problematic since they lacked a dependable income source. Most resettled herders relied mainly on caterpillar fungus sales. Some did construction work in summer.

Herders expressed deep frustration with the policy of 'sweeping away illiteracy' implemented in 2007 that aimed to educate every herder under the age of fifty. Because of this compulsory education, locals had no time for other work and families had no income from September to May.

Resettled herders had to purchase most necessities in town. The annual compensation of 6,000 RMB (USD750) was inadequate to support an entire family for a year. Resettled herders rarely found employment in town. In a typical herding family, each person received 0.33 USD per day. This was easily spent on education, health care, and food.

Several skills-training projects were conducted. The first was carpet weaving. A carpet factory was established in the resettlement area but closed after two months. Training projects on motor engine repair and tailoring followed. Skills learned in such programs did not help trainees find jobs because they lacked diplomas and fluency in the Chinese language, and their skills were rudimentary.

Social Impact of EMP on Relocated Herders

A major social impact of EMP on relocated herders was the change in their cultural environment from a traditional rural lifestyle to a modernized urban life.

The government paved the main road to the resettlement area but the closest primary school was two kilometers away. No public transport serviced the area and it was therefore necessary to walk to the other side of the valley to rent a taxi and pay ten RMB to reach town.

Additionally, other locals denigrated resettled herders. Many urban residents circumambulated a sacred mountain in the relocation vicinity prior to resettlement. After resettlement it was rumored that several pilgrims were robbed in the valley and many urban residents came to consider the resettled herders as thieves.

Community leaders were concerned about their future and anxious about the community's sustainability in this new situation. They no longer hoped to return to the grassland after ten years because they had no livestock. They were psychologically depressed, physically stressed, and economically impoverished.

CONCLUSION

This research analyzed how EMP impacted the grassland ecosystem and the relocated herders. Study results indicate that EMP had not improved Rtswa chog pasture conditions after 3.5 years, nor had it significantly improved the living condition of re-settled Rtswa chog nomads. Such results directly contradict the stated aims of EMP.

Thirty Rtswa chog households voluntarily resettled in Skye dgu Town and sold their livestock. Reduction of livestock density was achieved. However, assessment of the grassland's ecological condition indicated that there was no significant improvement in terms of species richness after EMP implementation. Grassland species composition had not changed

significantly three years after EMP implementation. The small ecological differences between the two sites were mainly due to annual precipitation, seasonal livestock grazing patterns, and annual and seasonal factors affecting grass growth. EMP did not significantly influence grassland species richness in Rtswa chog.

No significant difference was observed in terms of species composition diversity indices. Grass species diversity and frequency in Rtswa chog and Yul gyi nyi ma were similar. The main variance in the evenness of species distribution is attributed to differences in water availability and soil profile. EMP had no significant influence on the grassland in terms of species composition diversity indices.

Invasion of poisonous grass species at Rtswa chog was mainly due to the burrowing of pikas, which should be controlled through natural predators to help maintain a healthy, balanced grassland ecosystem.

EMP did not economically benefit locals; poverty alleviation was not realized. The majority of the resettled herders struggled to make a living as they shifted from a subsistence to a consumerist lifeway. The production system of the resettled herders changed from multi-livestock production to no source of production, consequently reducing herders' income. Relocated herders mainly depended on collecting and selling caterpillar fungus for cash income in 2007.

EMP implementation reduced livestock numbers in Rtswa chog, however, grassland condition was not improved, nor was local biodiversity enriched. There was no significant difference in the grassland ecosystem of Rtswa chog before and after EMP, and resettled herders were disenfranchised and deprived of a sustainable livelihood.